ask@shiv

Page 1

Gravitation

WORKSHEET- 6

PHYSICS

ready done

1. Find the percentage derease in the weight of the body when taken to a depth of 32 km below the surface of earth .Radius of the earth is 6400 km.
2. IMP On a planet whose size is the same and mass 4 times as that of our earth ,find the amount of workdone of lift 3 kg mass vertically upwards through 3 m distance on the planet . the value of g on the surface of earth is 10 m/s^2
3. ready done How much above the surface of earth does the acceleration due to gravity reduces by 36% of its value on the surface of earth .Radius of earth =6400 km .
4. An artificial satellite revolves round the earth at a height of 1000 km . the radius of the earth is 6.38×10^3 km . mass of the earth 6×10^{24} kg ; G $=6.67 \times 10^{-11}$ Nm^2 kg^{-2}.Find the orbital speed and period of revolution of a satellite .
5. A satellite orbits the earth at a height of 3.6×10^6 m from its surface .Compute its (a) kinetic energy (b) potential energy (c) total energy .Mass of satellite = 500 kg ; mass of the earth= 6×10^{24} kg ; radius of the earth $=6.4 \times 10^6$ m ; G $=6.67 \times 10^{-11}$ Nm^2 kg^{-2} .
6. You are given the following data : g=9.81 ms^{-2} , radius of earth $=6.37 \times 10^6$ m , the distance the moon from the earth $=3.84 \times 10^8$ m and the period of the moon revolution =27.3 days .Obtain the mass of the earth in two different ways .G $=6.67 \times 10^{-11}$ Nm^2 kg^{-2} .
7. Calculate the escape speed on the surface of a planet of mass 7.5×10^{25} gram , its radius 1.6×10^6 m .G$=6.67 \times 10^{-8}$ dyne cm^2 g^{-2} .
8. The escape speed from earth surface is 11 km^{-1} . A certain planet has a radius twice that of earth but its mean denity is the same as that of the earth .Find the value of escape speed from the planet .
9. IMP Three uniform spheres , each having mass M and radius R, are kept in a way that each touches the other two >find the magnitude of the gravitational force on any sphere due to other two .
10. Find the percentage derease in the weight of the body when taken to a height of 16 km above the surface of earth . Radius of the earth is 6400 km .

11. How much below the surface does the acceleration due to gravity become 70% of its value on the surface of earth. Radius of earth $= 6.4 \times 10^{6}$ m.

12. A what height above earth surface, value of g is same as in a mine 100 km deep.

Imp

13. Find the potential energy of a system of four particle each of mass m placed at the vertices of a square of side l. also obtain the potential at the center of the square

Imp

14. If a satellite is revolving around a planet of mass M in an elliptic orbit of semi major axix a, show that the orbital speed of the satellite when it is at a distance from the focus will be given by

$$v^2 = GM\,[2/r - 1/a].$$

15. Show that moon would depart for ever if its speed were increased by 42%.

16. Jupiter has a mass 318 times that of earth, and its radius is 11.2 times the earth radius. Estimate the escape speed of a body from jupiter surface, given that the escape speed from the earth surface is 11.2 km s^{-1}.

Q. 1 Q4.
Q 2. Q5.
Q 3.

Ch-6 GRAVITATION

[ask@shiva]
[Answer sheet - 1]

1. g when the body is taken to depth below surface of Earth,

$g_e = 10 \, m/s^2$

$g = \left(1 - \frac{d}{R}\right) g_e$

$= \left(1 - \frac{\cancel{32}^{1}}{\cancel{6400}_{200}}\right) \times 10$

$= \frac{199}{20\cancel{0}} \times \frac{1\cancel{0}\cancel{0}}{10} = 9.95 \, m/s^2$

2. Let R_e be the radius of the earth and R_p be that of planet.

$R_e = R_p$
$M_p = 4M_e$ (GIVEN)

$g_p = \frac{G \times 4M_e}{R_p^2}$ $\quad g_e = \frac{GM}{R_e^2}$

Comparing g_p and g_e, we get

$\frac{g_p}{g_e} = 4$ $\quad \therefore g_p = 4g_e$

$= 4 \times 10 = 40 \, m/s^2$

Work done to lift the body $= mgh$

$= 3 \times 40 \times 3$

$= 360 \, J$

3. $g_p = g_s - \frac{36}{100} g_s = \frac{64}{100} g_s$

$\frac{g_p}{g_s} = \frac{R^2}{(R+h)^2}$

$\frac{64}{100} = \frac{R^2}{(R+h)^2}$

$\therefore \frac{R}{R+h} = \frac{8}{10}$

$\therefore 10R = 8R + 8h$

$2R = h \quad \therefore \frac{2 \times \cancel{6400}^{800}}{} = 1600 \, km$

(4) Given: $h = 1000\ km$, $R_e = 6400\ km$, $m_e = 6\times10^{24}\ kg$

$G = 6.67\times10^{-11} Nm^2/kg^2$

$r = h + R = 7400\ km$

$$\left[T = \frac{2\pi r}{v}\right] \text{ — Time period}$$

Imp

$$v^2 = \frac{gR^2}{r}$$

Imp

$$v = R\sqrt{\frac{g}{r}} = 64\times10^5\sqrt{\frac{9.8}{74\times10^5}}$$

$$= \frac{64\times10^5}{10^3}\sqrt{\frac{49}{37}}$$

$$v = 7365\ m/s$$

$$T = \frac{2\pi r}{v} = 2\times\frac{22\times74\times10^5}{7\times7365}$$

$$= 6313\ s = 1.75\ hrs$$

(5) $h = 3.6\times10^6\ m$ $m_s = 500\ kg$ $m_e = 6\times10^{24}$

$r_e = 6.4\times10^6\ m$ $G = 6.67\times10^{-11} Nm^2/kg^2$

a) $K.E = \frac{1}{2} m v_0^2$

$$= \frac{1}{2}\times m\frac{gR^2}{R+h}$$

$$= \frac{1}{2}\times500\times9.8\times\frac{64\times64\times10^{10}}{10^7}$$

$$= 3136\times32\times10^5$$

$$\approx 10^{10}\ J$$

b) $P.E = -\frac{GMm}{r} = -\frac{GMm}{R+h}$

$$= -2K.E = -2\times10^{10}\ J$$

c) Total Energy $= 10^{10} - 2\times10^{10}\ J$

Q.6 Q9.
Q7. Q10.
Q8. Q11.
Q12.

⑥ $g = 9.8 m/s^2$, $r_e = 6.3 \times 10^6$, distance of moon from earth = 3.84×10^8, Time period of moon = 27.3 days

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

$$M = \frac{G\pi^2 r^3}{T^2 G}$$

$$= \frac{4\pi 2 \times (3.84)^3 \times 10^{24}}{(27.3 \times 24 \times 60 \times 60)^2 \times 6.67 \times 10^{-11}}$$

$$M_e = 6.02 \times 10^{24} \text{ kg}$$

⑦ $m_p = 7.5 \times 10^{22}$ kg ; $r_p = 1.6 \times 10^6$ m ; $G = 6.67 \times 10^{-11} Nkg^2/kg^2$ m

$$v_e = \sqrt{\frac{2GM_p}{R_p}}$$

$$= \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 7.5 \times 10^{22}}{1.6 \times 10^6}}$$

$$= \sqrt{\frac{6.67 \times 750 \times 10^4}{8}} = 100 \times 25$$

$$= 2500 m/s$$

⑧ $v_e = 11$ km/s. $m_e = 6.0 \times 10^{24}$ kg
$r_e = 6400$ km $r_p = 2 \times 6400 = 12800$ km

$$\rho_e = \rho_p \quad \text{(Given)}$$

$$\frac{m_e}{v_e} = \frac{m_p}{v_p}$$

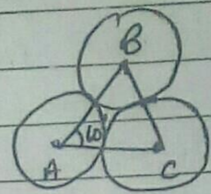
$$\frac{6 \times 10^{24}}{\cancel{\frac{4}{3}\pi} \cancel{r^3}} = \frac{m_p}{\cancel{\frac{4}{3}\pi}\, 8\cancel{r^3}}$$

$$48 \times 10^{24} \text{ kg} = m_p$$

$$v_p = \sqrt{\frac{2GM_p}{R_p}} = \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 48 \times 10^{24}}{128 \times 10^5}}$$

(solve it further yourself)

(9) Given that mass of each sphere is M and radius of each sphere is R



$\therefore$ Gravitation force on A by B $= \frac{GMM}{(2R)^2} = \frac{GMM}{4R^2}$

Similarly, gravitational force on A by C $= \frac{GMm}{4R^2}$

Resultant $\vec{F} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos 60^\circ}$

$= \sqrt{F_1^2 + F_2^2 + \cancel{2}F_1 \times \frac{1}{\cancel{2}}}$

$= \sqrt{3}F_1 = \frac{\sqrt{3}GM}{4R^2}$

(10) % decrease in the value of g $= \frac{2h}{R} \times 100$

$= \frac{2 \times 16}{640\cancel{0}} \times 10\cancel{0}$

$= \frac{1}{2} = 0.5\%$

(11) Decrease in value of g $= 100 - 70 = 30\%$

% decrease in value of g $= \frac{d}{R} \times 100$

$\frac{30}{100} = \frac{d}{R}$

$\therefore d = \frac{6.4 \times \cancel{10^6}^{10^4} \times 30}{\cancel{100}}$

$= 1.92 \times 10^6$ m $= 1.92 \times 10^3$ km

$= 1920$ km

(12) $g_d = g_h$

$\cancel{g_s}\left(1 - \frac{d}{R}\right) = \cancel{g_s}\left(1 - \frac{2h}{R}\right)$

Q13. [Q14, Q16. Q15] Not done

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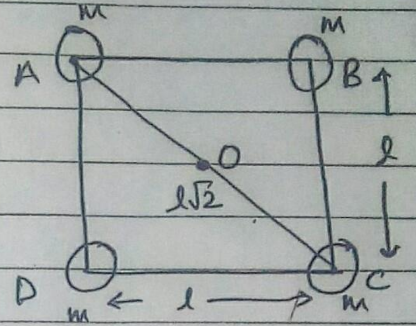
shiva

①

$$\frac{R-d}{R} = \frac{R-2h}{R}$$

$\therefore 2h = d$

$\therefore 2 \times h = 100 \quad \therefore h = 50\ km$



(13) $R_1 = l,\ R_2 = l\sqrt{2},\ R_3 = l/\sqrt{2}\ ;\ m = M$

P.E of system $= 4 \times -\frac{GmM}{R} + 2 \times -\frac{GMm}{\sqrt{2}\,l}$

$$= -\frac{4Gm^2}{l} - \frac{\sqrt{2}Gm^2}{l}$$

$$= \frac{-2Gm^2}{l}\left(2 + \frac{1}{\sqrt{2}}\right)$$

P.E of centre $= 4 \times -\frac{Gm^2}{R}$

$$= 4 \times -\frac{Gm^2}{l/\sqrt{2}}$$

$$= -4\sqrt{2}\,\frac{Gm^2}{l}$$

(15) $m_J = 318\ m_e \qquad r_J = 11.2\ r_e \qquad V_e = 11.2\ km/s$

$$v_j^2 = \frac{2 \times G \times 318\ m_e}{11.2 r_e} \qquad V_e^2 = \frac{2G\,m_e}{r_e} = 11.2$$

$$\frac{v_j^2}{v_e^2} = \frac{\cancel{2 \times G} \times 318\ \cancel{m_e}}{11.2\ \cancel{r_e}} \times \frac{\cancel{r_e}}{\cancel{2G\,m_e}}$$

$$\frac{v_j^2}{v_e^2} = \frac{318}{11.2}$$

$$v_j^2 = \frac{318 \times 11.2 \times \cancel{11.2}}{\cancel{11.2}}$$

$v_j = \sqrt{318 \times 11.2} = \cancel{5.96 \times 10^4\ m/s}$

$$= \sqrt{\frac{318 \times \cancel{112} \times 10^4 \times 112}{\cancel{112}}}$$

$= 5.96 \times 10^4\ m/s$